Introduction

In 1947, the Steelman report discussed the science and engineering (S&E) labor force in a chapter entitled "Manpower: The Limiting Resource," in which it stated that research and development (R&D) activities were limited by "the availability of trained personnel, rather than the amount of money available." It reported the pool of scientists and "research engineers" in the United States to be 137,000, of whom 25,000 had doctorates. In 1997, the National Science Foundation (NSF) estimated that there were 3.1 million workers in S&E occupations and a total of 10.1 million workers with S&E degrees.[1] In spite of these larger numbers of S&E workers, there is more of a debate today as to whether the size of the S&E workforce is a constraint on new knowledge, innovation, and technological advancement. It should be noted, however, that the vast majority of those with S&E degrees, particularly at the graduate level, are employed in jobs that are relevant to their degrees, and intensive technical knowledge finds uses in many places outside the laboratory.

This chapter first examines the major indicators and characteristics of the S&E labor force. Information on the sex and racial or ethnic composition of the S&E workforce is presented next, followed by a description of the labor market conditions for recent bachelor's, master's, and doctoral S&E degree recipients. A discussion of the impact of age and retirement on the S&E labor force is presented next. The chapter also provides data on the projected demand for S&E workers over the 1998–2008 decade. It concludes with a brief section on foreign-born scientists and engineers, and presents comparisons regarding international R&D employment.

Selected Characteristics of the S&E Workforce

The data in this section are from the NSF's Scientists and Engineers Statistical data system (SESTAT), which is a unified database primarily containing information on the employment, education, and demographic characteristics of individuals with S&E degrees in the United States. (See NSF 1999f.)[2,3]

How Large Is the U.S. S&E Workforce?

Estimates of the size of the U.S. S&E labor force can vary dramatically depending on what criteria are used to define a scientist or engineer. (See the sidebar, "Who Is a Scientist or Engineer?") Educational degree levels and fields, occupational categories, or a combination of these factors may all be taken into account.[4] In 1997, more than 12.5 million people in the United States either held degrees in science or engineering or were working as scientists or engineers. (See appendix table 3-1.) The number of individuals holding a college degree in an S&E field in 1997 exceeded by a large margin the number of persons working in an S&E occupation because many S&E degree holders were not working in an S&E field. Numerous individuals were also working in S&E occupations who were educated in fields not considered science or engineering related.

Basic Characteristics

Including those either with science or engineering degrees or in science or engineering occupations, approximately 12.5 million scientists and engineers were residing in the United States as of April 1997.[5] Only 84 percent (10.6 million) of these individuals, however, were in the workforce. (See appendix table 3-1.) The remainder were either unemployed, but seeking work (193,700), or were not in the labor force (1.75 million). Of the 10.6 million employed, the vast majority (10.1 million) held at least one college degree in a science or engineering field. About 30 percent (3.1 million) of the 10.1 million S&E degree holders in the workforce were also employed in S&E occupations. (See text table 3-1.)

Relationship Between Education and Occupation

Many of the Nation's scientists and engineers hold either multiple S&E degrees or have degrees in both S&E and non-S&E fields. Many S&E-educated workers also routinely find S&E-related employment in occupations not included in traditional S&E taxonomies. Of the 10.1 million S&E degree holders in the workforce in 1997, about three-fourths (7.7 million) reported that their highest degree was in an S&E field. (See appendix table 3-2.) Many of these individuals (4.9 million), however, were not principally employed in a traditional science or engineering occupation.

The likelihood of an S&E degree holder occupying an S&E job varies by field of degree. For example, about two-thirds (66 percent) of S&E degree holders whose highest degrees were in engineering fields were employed in an S&E job in

[1] Although this clearly shows great growth in science and engineering (S&E) education and employment, these numbers probably should not be used to estimate an exact 50-year growth rate. It is not immediately clear how the Steelman estimates were made, and the 1947 number may exclude many classes of workers included in the 1997 NSF estimate.

[2] Selected tables, copies of questionnaires, data quality control information, and the ability to perform simple tabulations from the public use version of SESTAT data are all available from <<http://sestat.nsf.gov>>.

[3] SESTAT data are collected from three component surveys sponsored by NSF and conducted periodically throughout each decade: (a) the National Survey of College Graduates, (b) the National Survey of Recent College Graduates, and (c) the Survey of Doctorate Recipients. SESTAT's target population is residents of the United States with a bachelor's degree or higher (in either an S&E or non-S&E field) who, as of the study's reference period, were:

•Noninstitutionalized,

•Not older than age 75, and

•Either degreed in science or engineering or working as a scientist or engineer—that is, either had at least one bachelor's or higher degree in an S&E field or had a bachelor's or higher degree in a non-S&E field and worked in an S&E occupation as of the reference week.

For the 1997 SESTAT, the reference period was the week of April 15, 1997.

[4] For a detailed discussion of the S&E degree fields and occupations in SESTAT, see NSF 1999a.

[5] This number includes all people who have ever received a bachelor's degree or higher in an S&E field, plus people holding a non-S&E bachelor's or higher degree who were employed in an S&E occupation during either the 1993, 1995, or 1997 SESTAT surveys.

Who Is a Scientist or Engineer?

There are many different definitions that can be use to classify a scientist or engineer—none of which are perfect. For a more thorough discussion of these complexities, see *SESTAT and NIOEM: Two Federal Databases Provide Complementary Information on the Science and Technology Labor Force* (NSF 1999c) and "Counting the S&E Workforce—It's Not that Easy" (NSF 1999d). Different definitions are used at different places for different analytic purposes in this report, and even more are used in reports elsewhere. These are the three major definitions used in this report:

- **Occupation:** The most common way of counting scientists and engineers in the workforce is to count those with an occupational classification that matches some list of S&E occupations. Although there can be considerable question of how well it is coded from individual write-ins or employer classifications, occupation comes closest to indicating what work a person is actually doing. An engineer by occupation may have a engineering degree, or not, but if classified correctly will be doing engineering work. One limitation of occupation is that it will not capture individuals using S&E knowledge, sometimes extensively, under occupational titles such as manager, salesman, or writer.* It is not uncommon for a person with a science or engineering degree in such occupations to report that their work is closely related to their degree, and in many cases also report R&D as a major work activity.
- **Highest degree:** This is another way to classify scientists and engineers if you want to count or describe the characteristics of individuals in the labor force with formal S&E training. Focusing on the field of highest (or most recent) degree often best characterizes the training an individual is utilizing in the labor force (rather than occupation, as discussed above). For example, it may be more appropriate to classify a person with a bachelor's degree in chemistry who is employed as a technical writer for a professional chemists society magazine as a chemist. Using highest degree does not solve all problems, however. For example, should a person with a bachelor's degree in biology and a master's degree in engineering be included among biologists or engineers? Also, should individuals with a bachelor's degree in political science be counted as social scientists if they also have a law degree? Many might be comfortable classifying by highest degree in the examples above, but less comfortable excluding from an S&E labor force analysis an individual with a bachelor's degree in engineering who also has a master's degree in business administration.
- **Anyone with an S&E degree or occupation:** Another approach is to use both occupation and education. NSF's sample surveys of individual scientists and engineers attempt to include those resident in the United States with any science or engineering degree, or with a science or engineering occupation.†

* In most collections of occupation data (SESTAT data mostly does not have this problem), the generic classification of post-secondary teacher also masks many university professors who should be included in most concepts of the S&E workforce.

† Those without U.S. S&E degrees are included in 1997 SESTAT data to the extent they were in the United States in 1990, 1993, 1995, and 1997 (in the case of individuals with foreign S&E degrees) or had at least a bachelor's degree in some field and were working in a S&E occupation in 1993, 1995, and 1997.

1997. However, most of the S&E degree holders who received their highest degrees in life science or social science fields (73 percent and 86 percent, respectively) were working in occupations outside the traditional S&E taxonomy, that is, "non-S&E occupations." (See appendix table 3-2.) About half of those with highest degrees in computer and mathematical sciences and physical sciences (51 percent and 46 percent, respectively) were also employed in a non-S&E occupation in 1997.

The fact that most S&E degree holders do not work in a strictly defined science or engineering occupation does not mean that they are not using their S&E training. Of the 4.9 million S&E degree holders working in non-S&E jobs in 1997, about 65 percent indicated they were working in jobs at least somewhat related to their highest S&E degree field. (See text table 3-2.)[6] Over three-fourths of those with highest degrees in computer and mathematical sciences who were employed in non-S&E jobs were doing work related to their degrees, compared to 61 percent of those whose highest degrees were in social and physical sciences.

Out of all employed individuals whose highest degree was in S&E, 74.8 percent said that their jobs were related to the field of their highest degree, and 44.8 percent said their jobs were closely related to their field.[7] This can be seen in appendix tables 3-3 and 3-4. The relatedness of a field of study to an individual's job differs in mostly predictable ways across level of degree, years since degree, and field of degree.

Figure 3-1 shows the percentage of employed S&E degree holders who say their jobs are closely related to their degrees by degree level and years since degree. For the period of one to five years after receiving their degree, 74.1 percent of S&E doctorates say their jobs are closely related to their field of

[6] Refers to highest degree received.

[7] Although this is a highly subjective self-assessment by survey respondents, it may often capture associations between training and scientific expertise not evident through occupational taxonomies. For example, an individual with an engineering degree, but with an occupation title of "salesman," may still be heavily involved in using or developing technology.

Text table 3–1.
Employed scientists and engineers, by S&E employment status and field of highest degree: 1997

	S&E Employment Status		
	Total	In S&E	In non-S&E
Total employed	10,585,600	3,369,400	7,216,200
Total with no S&E degree	528,000	294,600	233,400[a]
Total with S&E degree	10,057,600	3,074,800	6,982,800
S&E is highest degree	7,704,000	2,840,800	4,863,200
Computer & mathematical sciences	1,003,300	494,800	508,500
Life and related sciences	1,204,700	326,200	878,500
Physical and related sciences	619,200	334,100	285,100
Social and related sciences	2,967,600	421,300	2,546,300
Engineering	1,909,200	1,264,400	644,800
Non-S&E is highest degree	2,353,600	234,000	2,119,600

[a]These individuals were employed in an S&E occupation in a previous job.

NOTE: Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT Surveys, 1997.

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Text table 3–2.
Persons with S&E degrees employed in non-S&E occupations, by highest degree and relationship of degree to job: 1997

	Total[a]	Bachelor's	Master's	Doctorate
All non-S&E occupations	4,863,200	3,994,800	715,300	149,700
	Percent			
Total	100.0	100.0	100.0	100.0
Closely related	32.4	29.2	46.9	48.4
Somewhat related	32.3	32.4	31.5	33.7
Not related	35.3	38.5	21.6	18.0

[a] Includes professional degrees.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT surveys, 1997.

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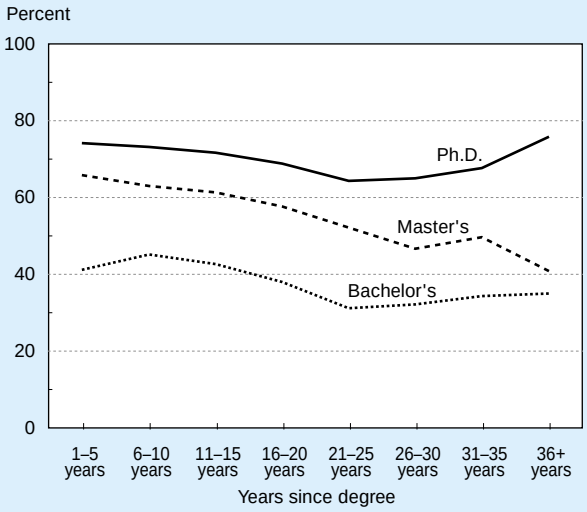
degree, compared to 65.9 percent of those with master's degrees and 41.1 percent of those with bachelor's degrees. This relative ordering of relatedness by level of degree holds across all years since receipt of degree. At every degree level, however, jobs generally become less closely related to field of degree as year since degree increases.[8] There may be many reasons for this—individuals change their career interests over time, they may gain skills in a different area while on the job, they may move into management responsibilities, or some of their original college training may become obsolete. Given all of these possibilities, the career cycle decline in the relevance of an S&E degree is fairly modest.

Differences in proportion for those who said their jobs were closely related to their field of degree are shown in Figure 3-2 for bachelor's degree holders by major groups of S&E disciplines. At one to five years after receipt of degree, the percentage of S&E bachelor's degree holders who said their jobs were closely related to field of degree ranged from 29 percent in the social sciences to 72 percent in computer science. Between the extremes of social sciences and computer sciences, most other S&E fields have similar percentages of recent graduates in closely related jobs—53 percent for physical sciences, mathematical sciences, and engineering, and 45 percent for the life sciences.

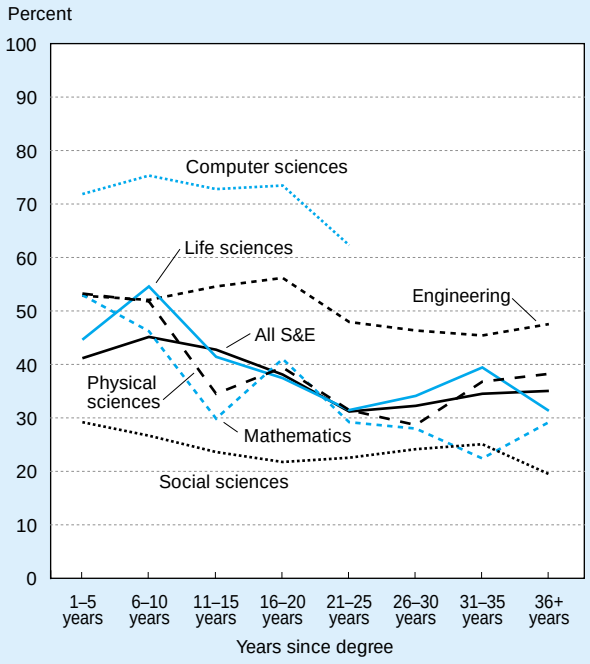
[8]One exception to this is for Ph.D. holders more than 25 years after degree, for whom the percent in closely related jobs increases. This may reflect differences in retirement rates.

Figure 3-1.
Percentage of S&E degree holders in jobs "closely related" to their degrees



See appendix table 3-3. *Science & Engineering Indicators – 2000*

Figure 3-2.
S&E bachelor's degree holders in jobs "closely related" to their degrees



See appendix table 3-3. *Science & Engineering Indicators – 2000*

Employment in Non-S&E Occupations

A little over half of the 4.9 million S&E degree holders working outside S&E occupations in 1997 were employed in either management-administration occupations (29 percent), sales and marketing jobs (16 percent) or non-S&E related teaching positions (9 percent) in 1997. (See text table 3-3.) Almost 90 percent of those employed as non-S&E teachers said that their work was at least somewhat related to their S&E degree field, compared to 71 percent of managers-administrators and 47 percent of those employed in sales and marketing jobs.

About 82 percent of the 4.9 million S&E degree holders not working in S&E occupations in 1997 reported their highest degree as a bachelor's degree, while 15 percent listed a

Text table 3–3.
Persons with S&E as highest degree employed in non-S&E occupations, by occupation and relationship of degree to job: 1997

		Percent			
		Relationship of highest degree to job			
Occupation	Total	Total	Closely related	Somewhat related	Not related
Total non-S&E occupations	4,863,200	100.0	32.4	32.3	35.3
Managers and administrators	1,405,000	100.0	29.7	41.4	28.8
Health and related occupations	294,800	100.0	61.0	23.4	15.6
Non-S&E teachers	454,300	100.0	66.9	20.4	12.6
Non-S&E postsecondary teachers	48,700	100.0	68.4	21.7	9.9
Social services occupations	270,800	100.0	60.1	29.1	10.8
Technologists and technicians	309,800	100.0	44.9	33.6	21.5
Sales and marketing occupations	757,500	100.0	10.2	36.8	53.0
Art and humanities occupations	114,800	100.0	19.2	36.8	43.9
Other non-S&E occupations	1,207,500	100.0	19.8	25.7	54.4

NOTE: Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT surveys, 1997.

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master's degree and 3 percent a doctorate. Approximately three-fifths of bachelor's degree holders reported that their jobs were closely related to their highest degree field, compared to four-fifths of both doctorate and master's S&E degree recipients.

Employment in S&E Occupations

Of the 7.7 million scientists and engineers in the workforce in 1997 whose highest degrees were in an S&E field, a little more than a third (2.84 million) were principally employed in S&E jobs. Additionally, there were 234,000 individuals with S&E degrees whose highest degrees were in a non-S&E field who were also employed in S&E occupations. There were also 294,600 college-educated individuals employed in S&E occupations that held no degrees in an S&E field.

Altogether, approximately 3.4 million individuals were employed in an S&E occupation in 1997. (See appendix table 3-5.) Engineers represented 41 percent (1.37 million) of the S&E positions, followed by computer and mathematical scientists with 31 percent (1.04 million) of the total. Physical scientists accounted for less than 10 percent of those working in S&E occupations in 1997. By subfield, electrical engineers made up about one-fourth (365,000) of all those employed as engineers, while biological scientists accounted for a little over one-half (182,000) of the employment in the life sciences. In the physical and social science occupations, chemists (120,000) and psychologists (182,000) were the largest occupational subfields, respectively.

Almost 57 percent of the individuals employed in S&E jobs reported their highest degree type as a bachelor's degree, while 29 percent listed a master's degree and 14 percent a doctorate. Other first professional degrees were reported as the highest degree type by about 1 percent. Almost half of those with bachelor's degrees were employed as engineers. (See text table 3-4.) Another 35 percent of bachelor's degree holders had jobs as computer and mathematical scientists. These occupations were also the most prevalent among those with master's degrees (39 percent and 31 percent, respectively). Most doctorate holders were employed as social scientists (27 percent), life scientists (25 percent) and physical scientists (18 percent). (See the sidebar, "How Important Is Temporary Work for Scientists and Engineers?") (See also the sidebar, "Data on Recent Ph.D. Recipients in Professional Society Data.")

Unemployment

Of the approximately 3.5 million scientists and engineers in the labor force in 1997, only 1.5 percent (52,900) were unemployed. (See figure 3-4.)[9] This compares with 4.9 percent for the U.S. labor force as a whole in 1997 and 2.0 percent for all professional specialty workers. The highest unemployment rates were for life scientists (2.2 percent) and the lowest for social scientists (1.0 percent). By degree level, 1.6 percent of the scientists and engineers whose highest degree was a bachelor's degree were unemployed, compared to 1.4 percent of those with master's degrees or a doctorate. It should be remembered, however, that the unemployment rate is a poor indicator of labor market conditions for highly educated workers—it does not measure how well their employment uses their training.

Sector of Employment

The private for-profit sector is by far the largest employer of S&E workers. In 1997, 73 percent of scientists and engineers with bachelor's degrees and 60 percent of those with master's degrees were employed in a private, for-profit company. (See appendix table 3-6.) The academic sector was the largest sector of employment for those with doctorates (49 percent). Sectors employing smaller numbers of S&E workers include educational institutions other than four-year colleges and universities, nonprofit organizations, and state or local government agencies.

[9]The unemployment rate is the ratio of those who are unemployed and seeking employment to the total labor force (that is, those who are employed plus those who are unemployed and seeking employment). Those who are not in the labor force (that is, those who are unemployed and not seeking employment) are excluded from the denominator. For unemployed individuals, occupation is for their last reported job.

Text table 3–4.
Percentage distribution of employed scientists and engineers by broad occupation and highest degree: 1997
(Percent)

	Total[a]	Bachelor's	Master's	Doctorate
All S&E occupations	100.0	100.0	100.0	100.0
Computer and math scientists	30.8	35.2	31.2	13.0
Life and related scientists	9.5	6.5	7.3	24.6
Physical and related scientists	8.5	6.9	7.1	18.4
Social and related scientists	10.4	3.5	15.6	26.6
Engineers	40.8	47.8	38.8	17.5

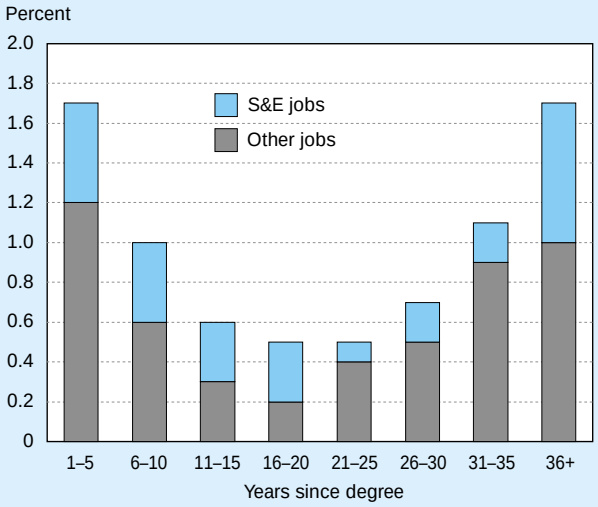
[a] Includes professional degrees.

See appendix table 3–6. *Science and Engineering Indicators – 2000*

How Important Is Temporary Work for Scientists and Engineers?

One common form of flexible work arrangement in the general labor force is the temporary help firm. Although best known as a way for businesses to hire temporary clerical help, major temporary help firms have long included scientists, engineers, and technicians among the workers whom they offer to other businesses on a temporary basis. How important is temporary work as a source of employment for those with S&E degrees? The answer appears to be "not very" for most S&E degree holders. Figure 3-3 shows the percentage of S&E degree holders who in 1997 reported being employed by a temporary help or employment agency. The greatest use of temporary firms occurs for those within just one to five years since receipt of their degrees (1.7 percent) and for those with more than 35 years since receipt of their degrees (1.6 percent). Only about one-third of those with temporary agency jobs are employed in S&E occupations. Ph.D. recipients are less likely than those with other S&E degrees to work for a temporary agency—only 0.4 percent even within one to five years since receipt of degree.

Figure 3-3.
S&E degree holders working through a temporary help or employment agency: 1997



See appendix table 3-20. *Science & Engineering Indicators – 2000*

Among S&E occupations, there was a wide variation in the proportions of scientists and engineers employed in private for-profit industry. While nearly three-fourths of both computer and mathematical scientists and engineers were employed in this sector, only one-fourth of life scientists and one-fifth of social scientists were so employed in 1997. Educational institutions employed the largest proportion of life scientists (48 percent) and social scientists (45 percent).

Salaries

In 1997 the median annual salary of bachelor's degree holders employed in S&E occupations was $52,000; for master's recipients it was $59,000 and for doctorate holders $62,000. (See figure 3-5 and appendix table 3-7.) Engineers commanded the highest salaries at each degree level. The second highest salaries were earned by computer and mathematical scientists at the bachelor's and master's levels, and physical scientists and computer and mathematical scientists at the doctorate level. The lowest median salaries were reported for social scientists at each degree level.

Median salaries for scientists and engineers were higher for those with more years since completion of their highest degree. For example, individuals who earned their bachelor's or master's degrees five to nine years ago earned about $12,000 and $8,000 less, respectively, in 1997 than those who received these degrees 15–19 years ago. For doctorate holders, the difference between the two groups in terms of years since receipt of degree was $14,000. (See appendix table 3-8.)

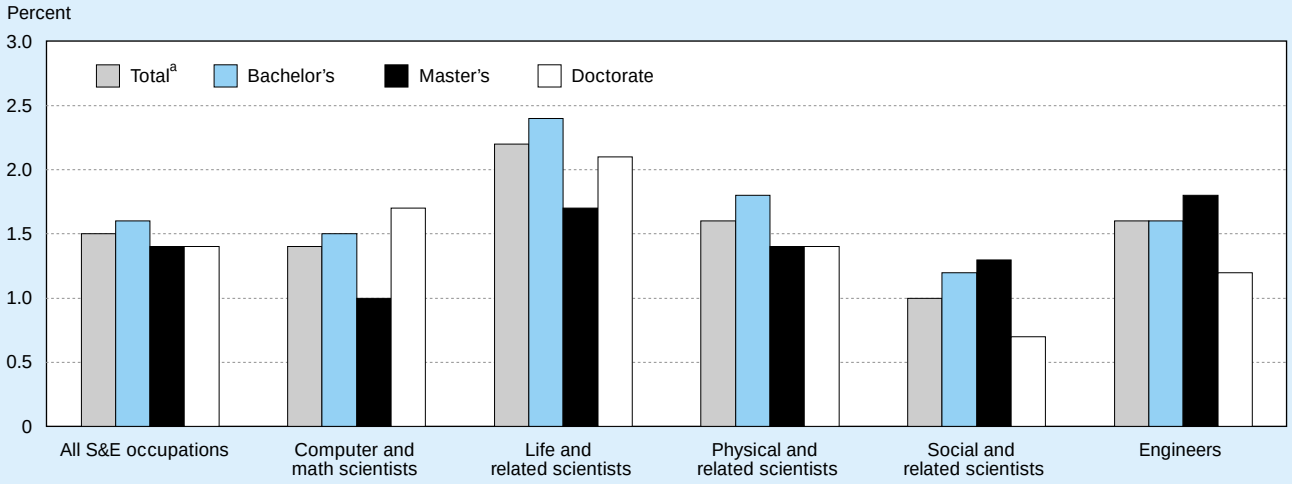
Who Performs R&D?

Although individuals with an S&E education can use that knowledge in a great many other ways—for example, teaching, writing, evaluating, and testing—there is a special interest in those engaged in research and development (R&D). Figure 3-6 shows the distribution of individuals with S&E degrees who reported R&D as a major work activity by level of degree.[10] Those with doctorates comprise only 5.6 percent of all with S&E degrees, but 13.0 percent of those reporting major R&D activities. Despite this, a majority of the S&E degree holders that report major R&D activities have only bachelor's degrees (55.5 percent). Another 28.5 percent have master's degrees, and 2.9 percent have professional degrees (mostly in medicine). Figure 3-7 shows the distribution of individuals with S&E degrees who reported R&D as a major work activity by field of highest degree. Those whose highest degree is in engineering constitute more than one-third (34.9 percent) of those reporting major R&D work activities. Notably, 13.0 percent do not have their highest degree in an S&E field. In most cases, this is a person with an S&E bachelor's degree and a higher degree in a professional field, such as business, medicine, or law.

The involvement of S&E Ph.D. recipients in R&D as a major work activity is shown by field of degree and years since receipt of Ph.D. in figure 3-8. The highest R&D rates over the career cycle are found in the physical S&E. The lowest R&D rates are in the social sciences. While the percentage of employed Ph.D. recipients with R&D as a major work activity does decline with years since degree, it remains above 50 percent in most fields. A steeper decline might have been

[10]Counts of full-time equivalent R&D workers in the United States are based largely on NSF/SRS surveys of employers, rather than the self-reported R&D activity reported in SESTAT that is used here. The comparative advantage of the SESTAT data is the ability to know the characteristics of the individuals involved. Major work activity is defined here as an activity on which an individuals reports spending the most, or the second most, total hours.

Figure 3-4.
Unemployment rates of scientists and engineers by broad occupation and highest degree: 1997



See appendix table 3-5.

NOTE: Individuals are characterized as scientists or engineers based on their current occupation of employed, or on their last reported occupation if unemployed. These figures do not reflect those S&E degree holders employed in non S&E occupations.

[a] Includes professional degrees.

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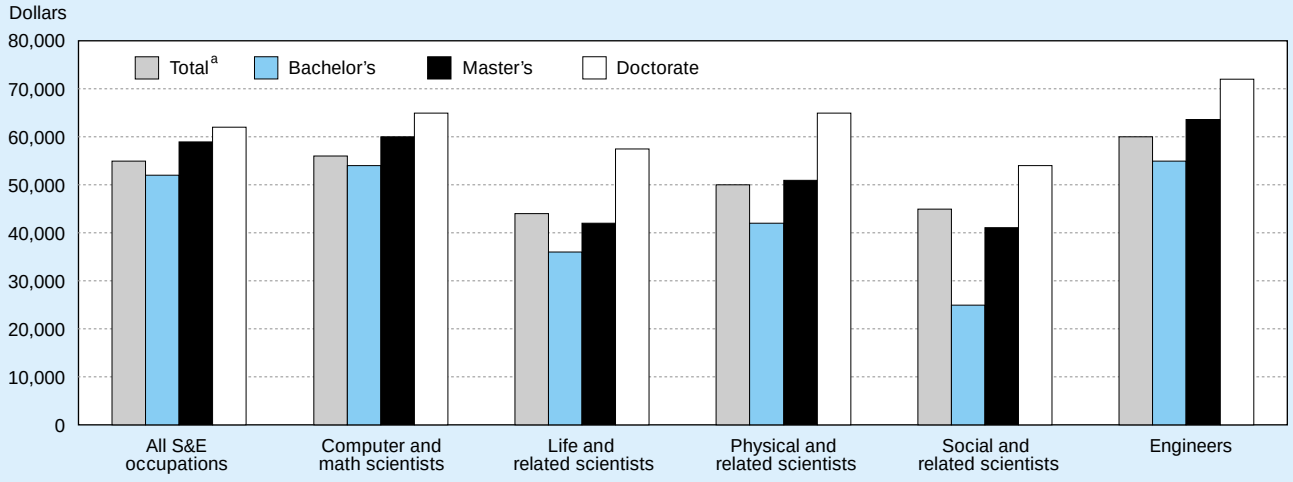
Figure 3-5.
Median annual salaries of employed scientists and engineers by broad occupation and highest degree: 1997



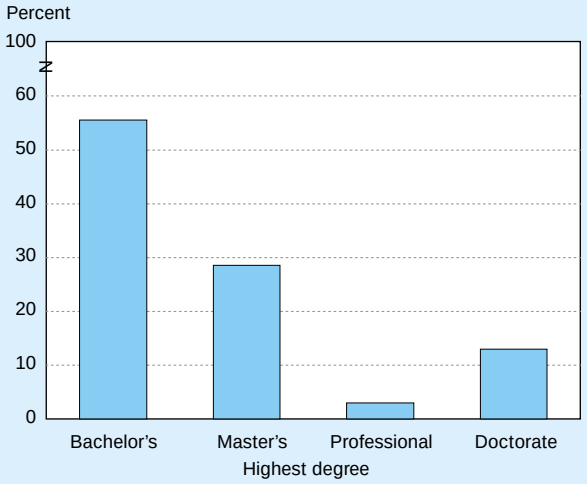
See appendix table 3-8.

NOTE: Individuals are characterized as scientists or engineers based on their current occupation.

[a] Includes professional degrees.

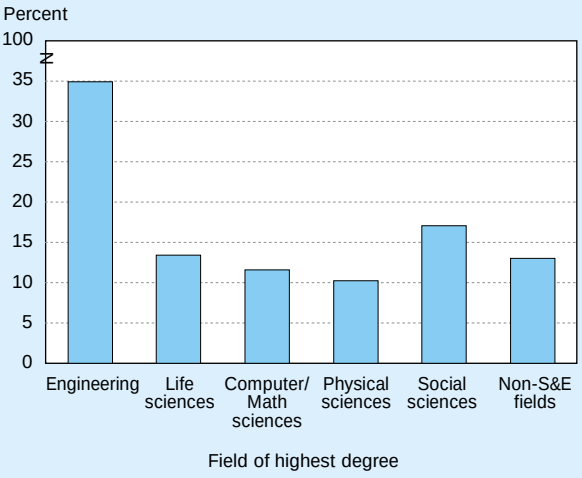
Science & Engineering Indicators – 2000

Figure 3-6.
Distribution of S&E R&D workers by degree level



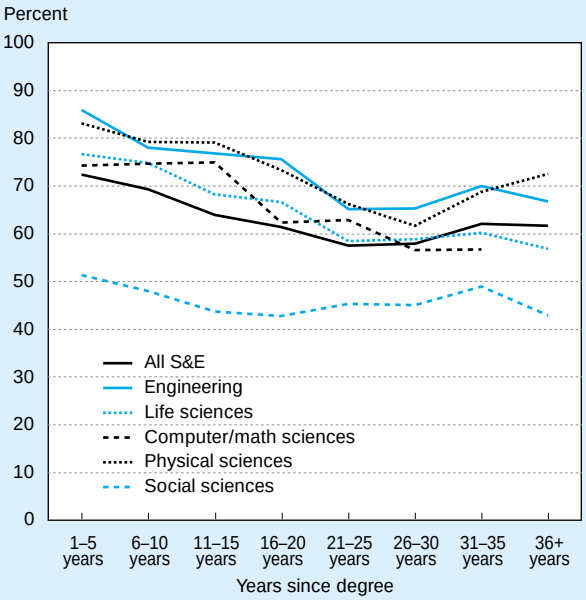
See appendix table 3-26. *Science & Engineering Indicators – 2000*

Figure 3-7.
Distribution of S&E R&D workers by field of highest degree



See appendix table 3-26. *Science & Engineering Indicators – 2000*

Figure 3-8.
Percentage of S&E Ph.D. holders engaged in R&D as a major work activity



See appendix table 3-27. *Science & Engineering Indicators – 2000*

expected, which may reflect a normal career process of movement into management or into other career interests.

Women and Minorities in S&E

This section examines the participation and employment characteristics of women and minorities in the S&E labor force in 1997. Representation is examined, in most cases, in terms of age, time in workforce, field of employment, and highest degree level.[11] These factors influence employment patterns. To the extent that men and women, minorities, and nonminorities differ on these factors, their employment patterns are likely to differ as well.

Within the S&E labor force, the age distributions of women compared to men, and of minorities compared to the majority, are quite different. Because large numbers of women and minorities have entered S&E fields only relatively recently, women and minority men are generally younger and have fewer years of experience. (See appendix table 3-9.) Age or stage in career is an influence on such employment-related factors as salary, rank, tenure, and work activity. Employment patterns also vary by field, and these field differences may influence employment in S&E jobs, unemployment, salaries, and work activities. Highest degree earned is also an important influence on employment, particularly on primary work activity and salary.

Women Scientists and Engineers

Representation in S&E

Women were slightly more than one-fifth (23 percent) of the S&E workforce, but close to half (46 percent) of the U.S. labor force in 1997. Although changes in the NSF surveys do not permit analysis of long-term trends in employment, short-term trends show some increase in the representation of women with doctorates in S&E employment: women represented 23 percent of scientists and engineers with doctorates in the United States in 1997. (See appendix table 3-10.) In 1993, they represented 20 percent and in 1995 22 percent.[12]

[11]Throughout this section, scientists and engineers are defined in terms of field of employment, not degree field.